ALRED

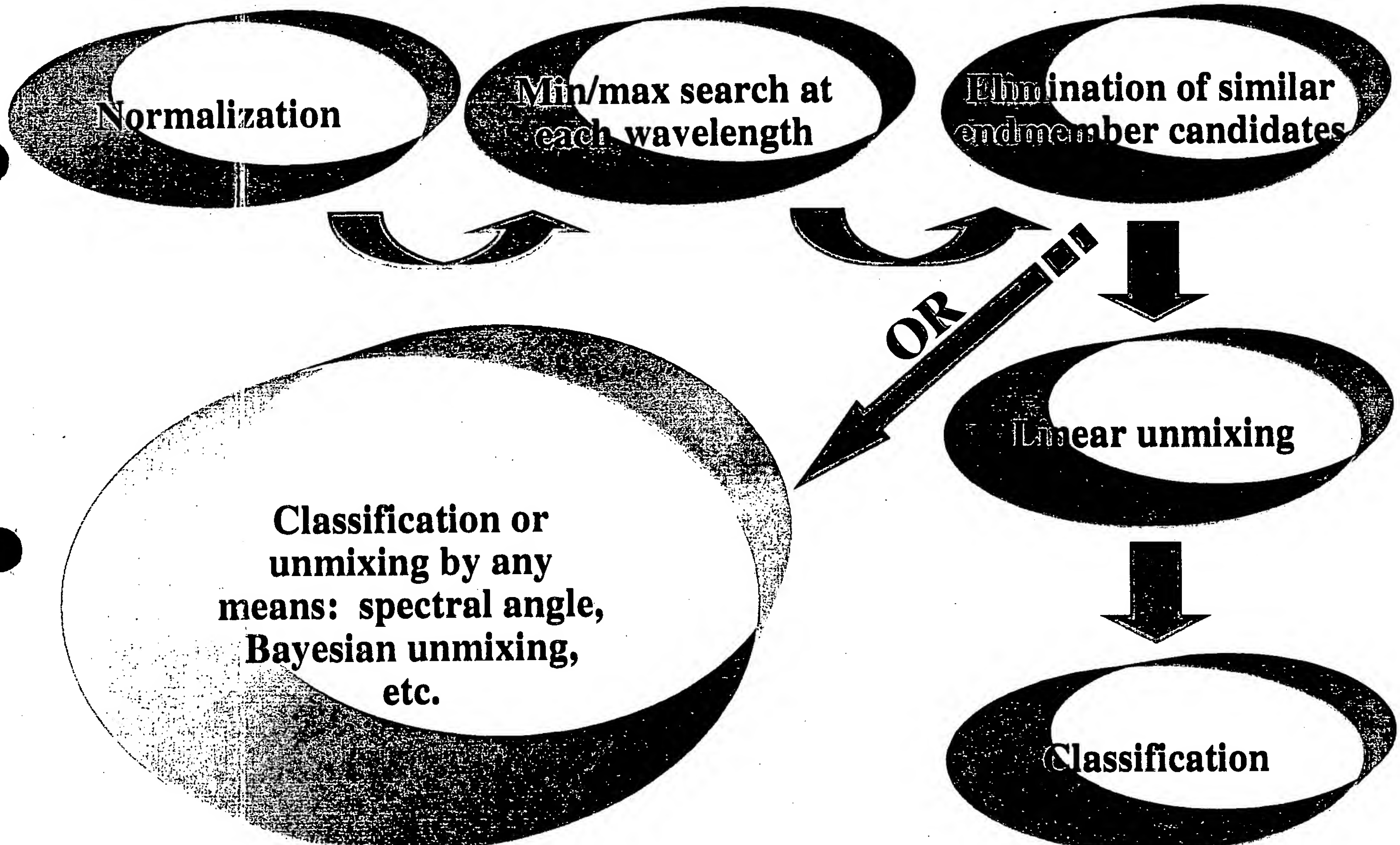


FIGURE 1

SPECTRAL ANGLE

- Treats spectra as vectors in a multi-dimensional space

- Coordinate axes of this space are the individual wavelengths for the spectra

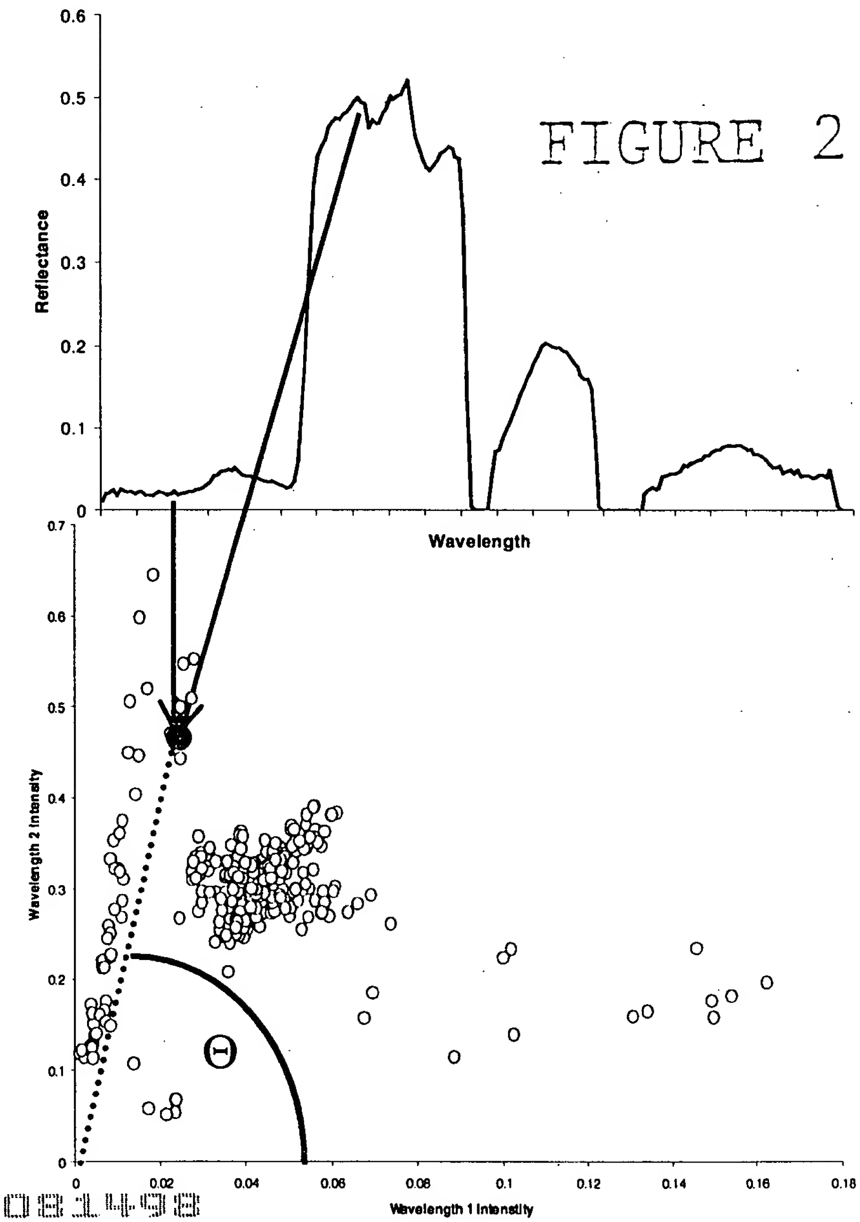


FIGURE 2

09137868 .081498

Spectral Angle Clustering

- The shape of a spectrum is represented by its spectral angle
- Supposition: items with the same reflectance spectrum with different illuminations should have the same spectral angle, but different apparent reflectance magnitudes
- Objects of similar spectral shape should cluster along *directions* even when illumination varies

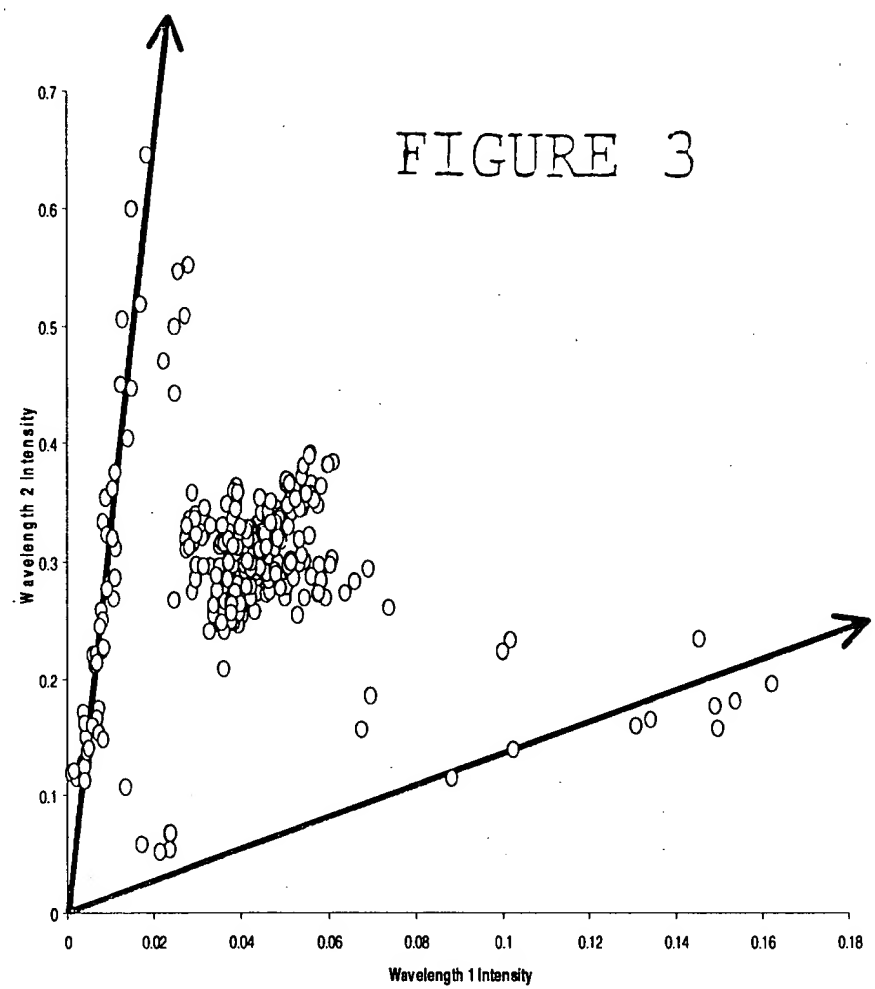


FIGURE 3

09137868 .081498

Principal Components Analysis

- PCA is used to reduce the dimensionality of the data set
- PCA also further separates classes of pixels along spectral angle
- Time consuming, but vital to reducing the search time for clusters along spectral angle directions

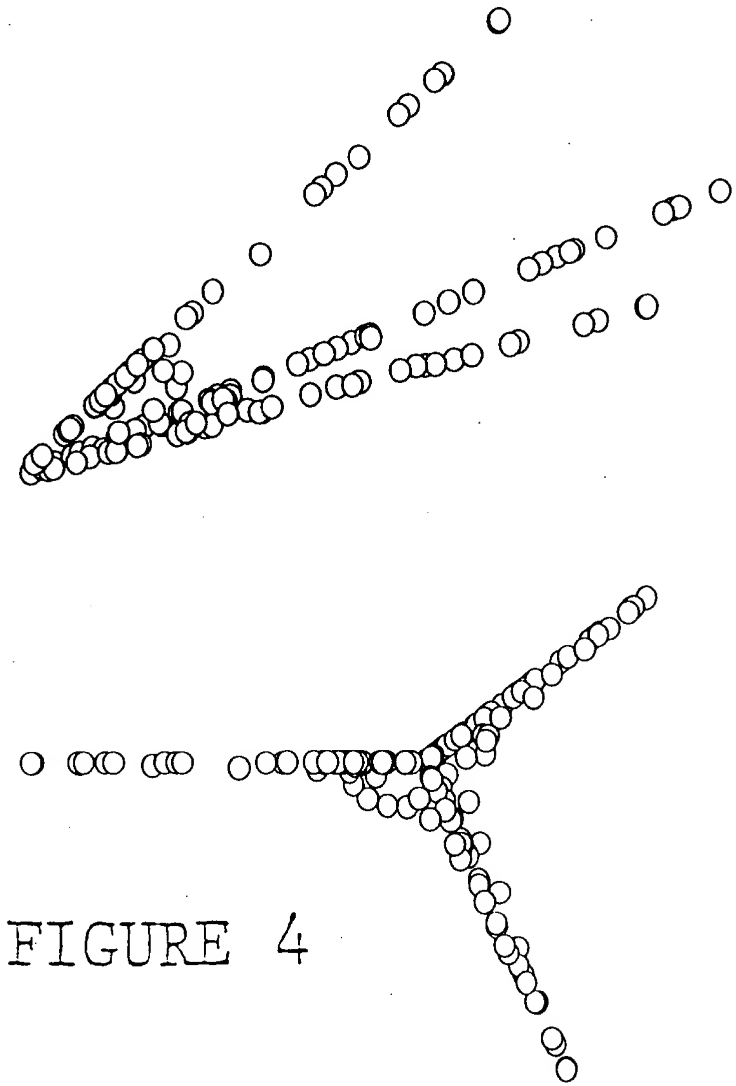
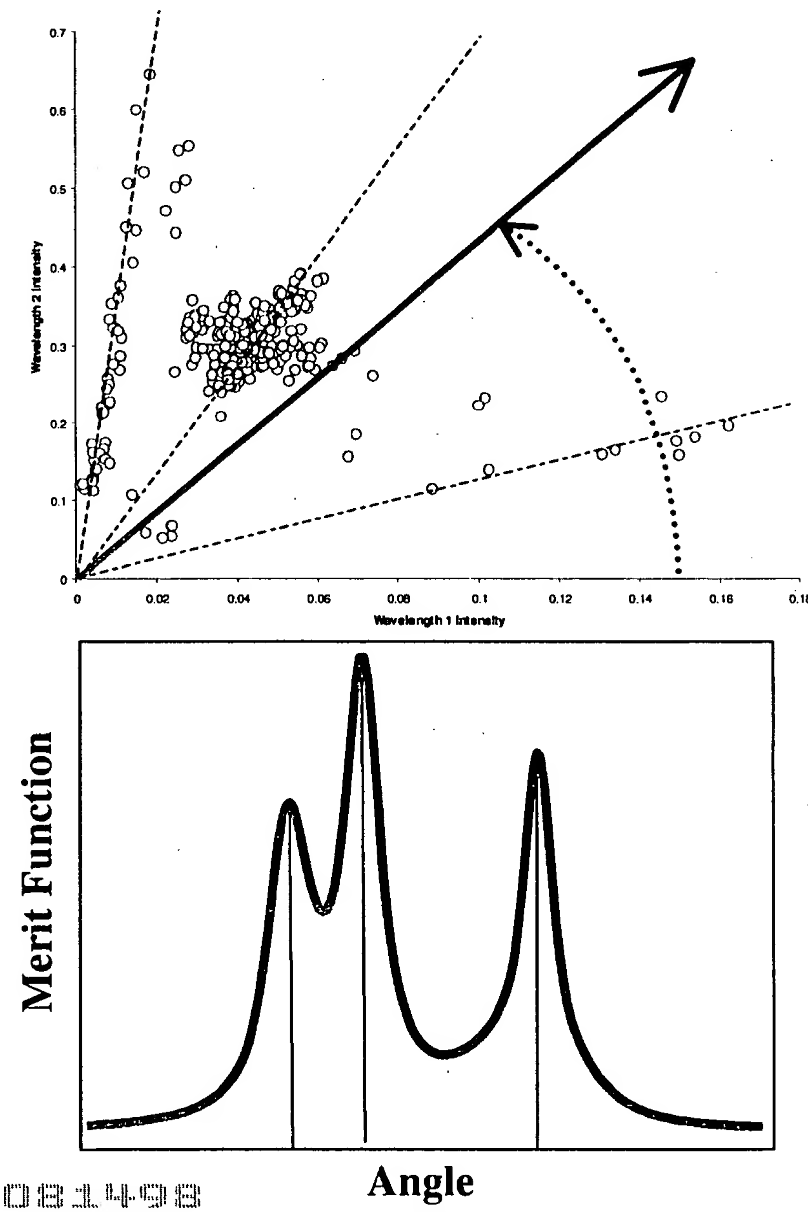


FIGURE 4

PATTERN RECOGNITION

- A line from the origin is incrementally swept through the data
- At each angle, a merit function is calculated for the data with respect to that angle
- The merit function preferentially weights points along the chosen angle and far from the origin (to be resistant to noise)
- Peaks in the resulting merit function map represent a distinct class of objects



09137868 .081498

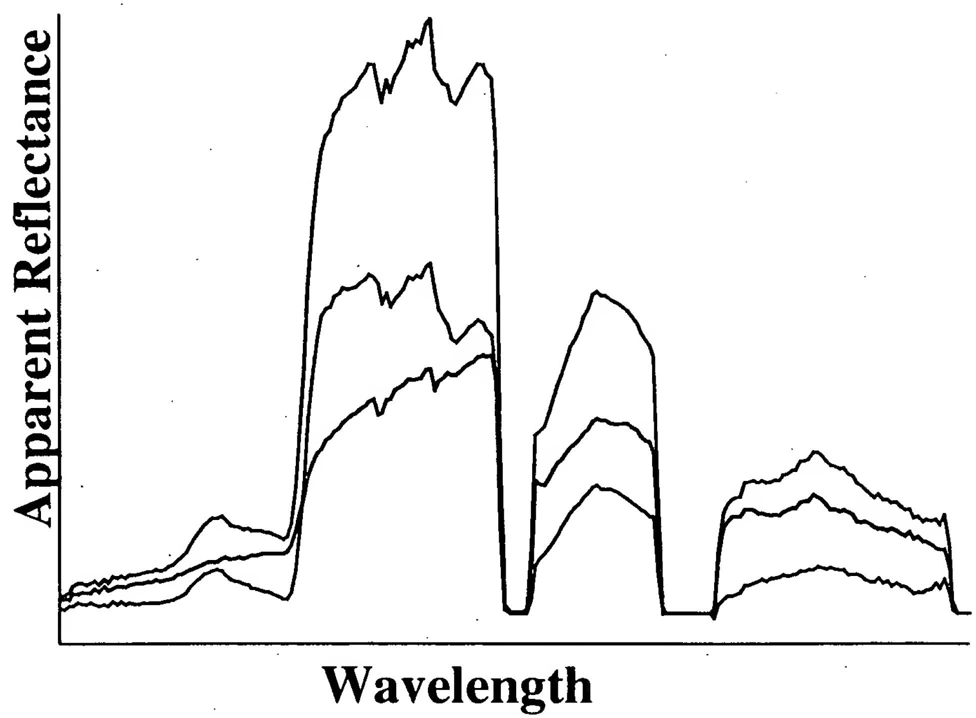
FIGURE 5

BAYESIAN UNMIXING

- Converts spectra into probability distributions

- Uses Bayes' Theorem to 'unmix' the fractional contribution of each endmember

- Constrains the unmixing result to have coefficients for each endmember
  $0 \leq C_i \leq 1, \Sigma C_i = 1$



09137868 .081498

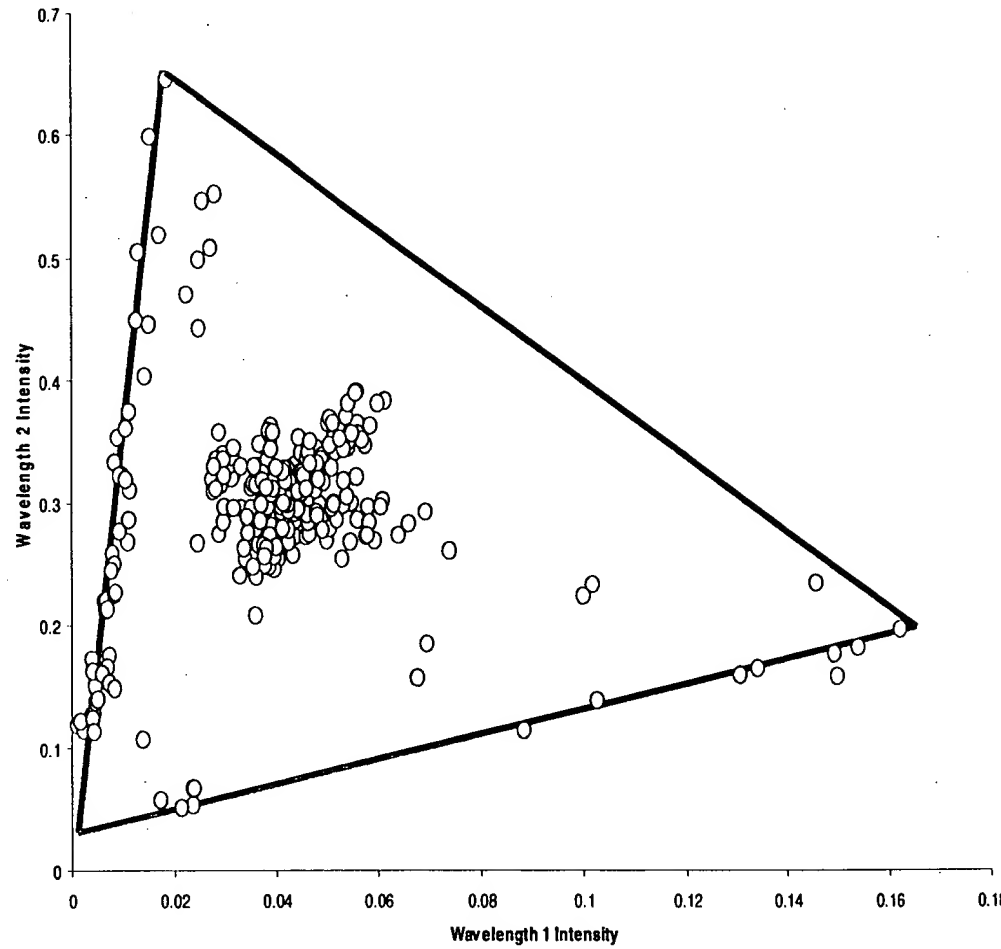
FIGURE 6

CONVEX HULL MODEL

- Endmembers are corners of simplexes fit around the data set

- Points inside of simplex are linear combinations of the vertices with coefficients summing to one.

- Different view of things than Spectral Angle



09137868 .081498

FIGURE 7

FAST ENDMEMBER RETRIEVAL

- Outliers in magnitude at individual wavelengths are good endmember candidates -- and are EASY to find

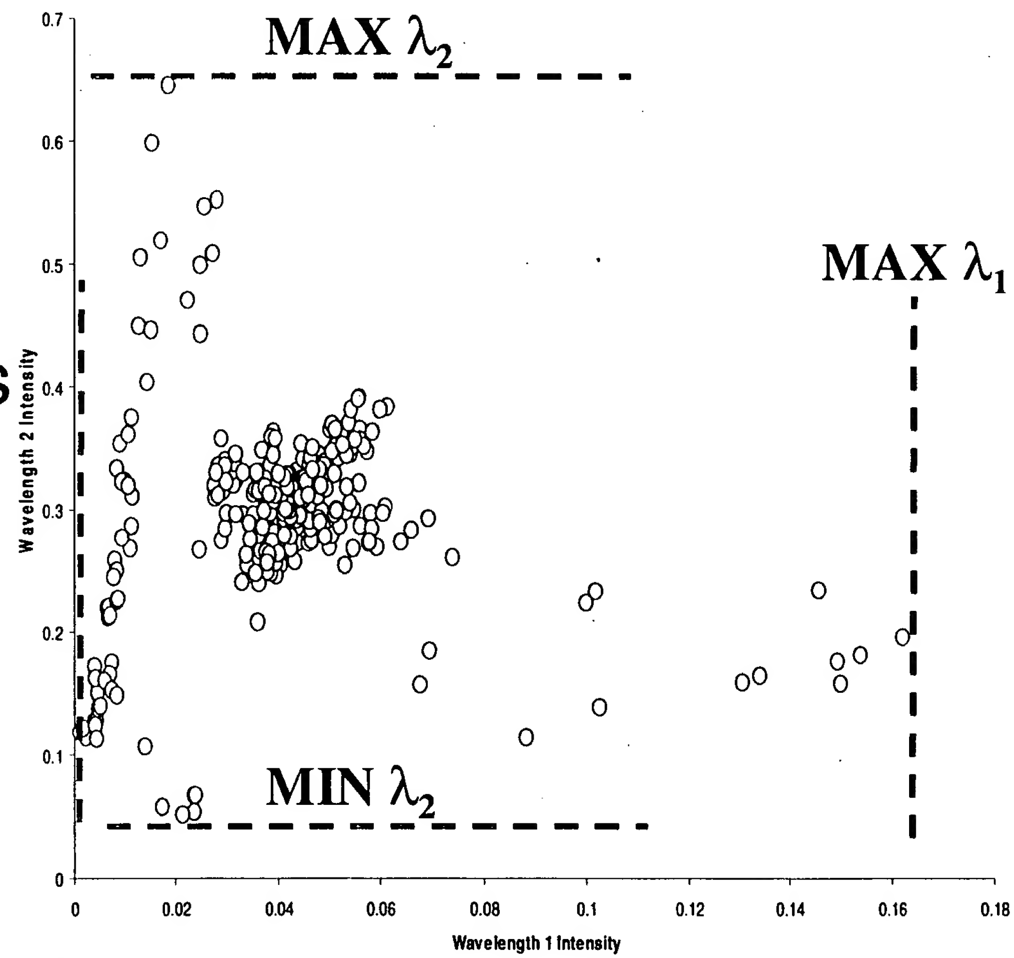
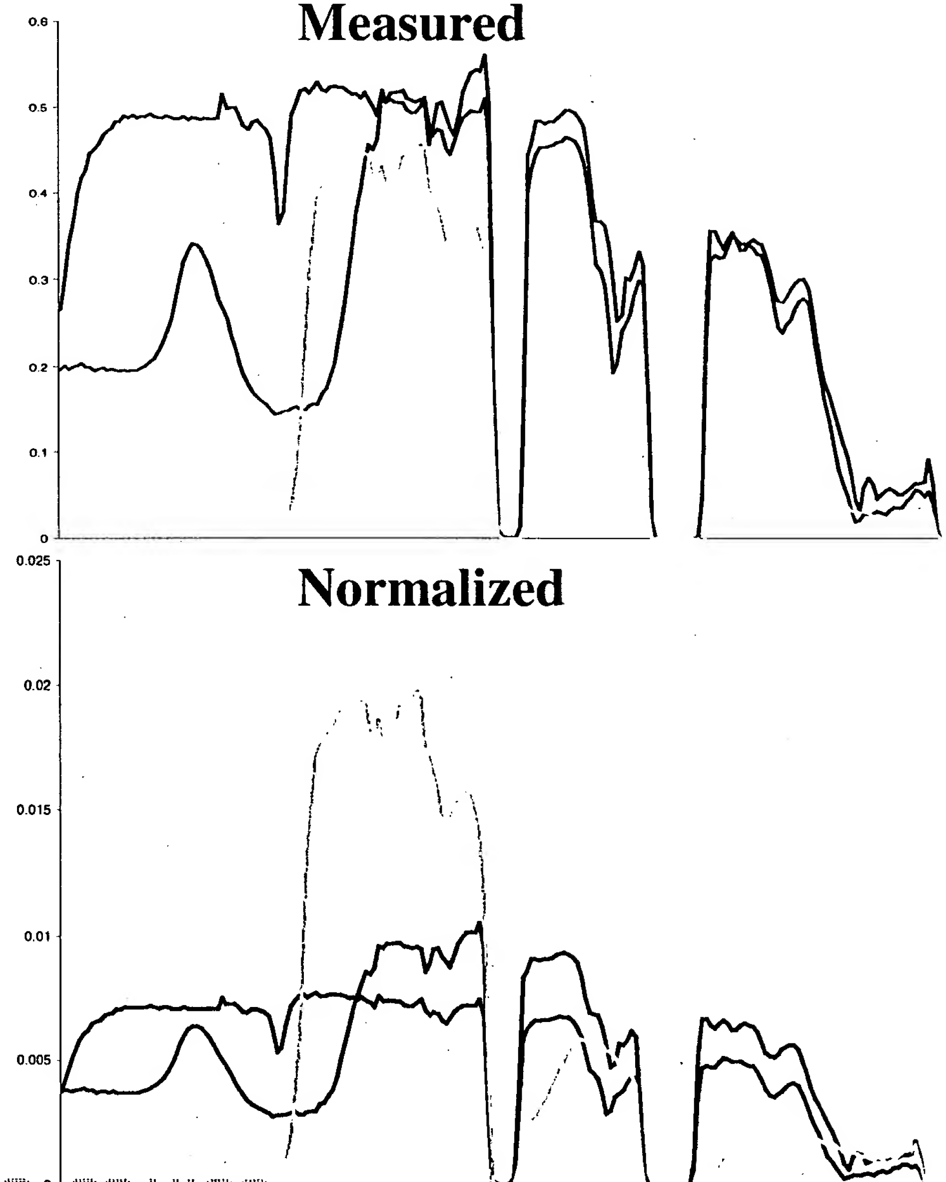


FIGURE 8

09137868 .081498

NORMALIZATION

- The min/max approach will not always find the simplex vertices
- Simplex vertices don't tell the whole story -- we really want unique spectral shapes
- Pixels with unique spectral shapes may be missed due to pixels with overall higher reflectance or greater illumination
- Normalization solves this -- note that we are no longer really trying to grab simplex vertices



09137868.081498

FIGURE 9